NOTES ON SILURIAN FOSSILS FROM OHIO AND OTHER CENTRAL STATES.

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The order of succession of Silurian strata in southeastern Indiana and the adjacent parts of Kentucky, in descending order, is as follows:

Louisville limestone,
Waldron shale,
Laurel limestone,
Osgood clay and limestone,
Brassfield limestone.

The Waldron clay shale has not been traced north of Waldron, St. Paul, and Milroy, the latter village being seven miles south of Rushville, Indiana. The Louisville limestone thins out eastward, beneath the Devonian, there being an unconformity between the top of the Louisville exposures and the base of the Devonian. Typical Louisville limestone can be traced eastward as far as Madison and the outcrops along Big Creek, southeast of Dupont. Between Vernon and Milroy the equivalent of the Louisville limestone is poorly supplied with fossils and rarely exceeds ten feet in thickness. Farther north it has not been recognized as a distinct horizon, separable from the general upper Niagaran section. Neither the Waldron nor the Louisville member has been recognized in Ohio.

The order of succession of Silurian strata in the northern tier of counties in southwestern Ohio, including Preble, Montgomery, Greene, Clarke, Champaign, Miami and Darke Counties, in descending order, is as follows:

Durbin formation { Cedarville dolomite / Springfield dolomite / Euphemia dolomite }
Laurel limestone
Osgood clay shale
Dayton limestone
Brassfield limestone.

The Euphemia dolomite is the very porous Mottled Zone of Prosser (The Classification of the Niagaran Formations of Western Ohio, Journal of Geology, 1916, pp. 334–365), and was identified by Orton with his West Union formation, of the more southern counties of Ohio. The Euphemia dolomite can not be identified west of New Paris, nor south of Cedarville, Ohio.

The same statement may be made regarding the Springfield dolomite. It also has not been identified west of New Paris nor south of Cedarville. Where the pike crosses the creek, half a mile west of Port William, fourteen miles south of Cedarville, the lower strata belonging to the dolomitic Niagaran series no longer can be identified definitely as Springfield. The Springfield dolomite is regarded as a lithologic phase of the dolomitic Niagaran series. Similar fine-grained strata, but not so well bedded, are known also higher in the section. The Euphemia dolomite is regarded as inaugurating this dolomitic series, and the term Durbin formation is proposed, to include them all: the Euphemia, Springfield, and Cedarville dolomites. Durbin is a railroad station about a mile west of the Mills quarries which are located south of the railroad from Springfield to Troy, about a mile southwest of Springfield, Ohio, and the exposures here form the type section. The Springfield and Cedarville dolomites are well exposed also immediately northeast of Durbin.

The Laurel limestone, containing Pisocrinus gemmiformis and Stephanocrinus, is represented by typical exposures at New Paris, Ohio. At the Carl quarry, three miles southwest of Lewisburg, near Brennersville, there is another typical exposure, containing the same fossils. East of this locality, the Laurel limestone is identified only stratigraphically, the name being employed for those strata which intervene between the Osgood clay and the base of the Euphemia dolomite.

In the vicinity of Osgood, and southward in Indiana and Kentucky, the Osgood formation consists of a clayey section, a relatively thin limestone, frequently fossiliferous, and a second clay section, also thin, and occasionally also fossiliferous. The characteristic Osgood fossils occur chiefly in the Osgood limestone, but, locally, are abundant also in the upper parts of the lower Osgood clay and in the lower part of the upper Osgood clay. Even the characteristic cystids, described by S. A. Miller as species of *Holocystites*, are found in the lower part of the upper Osgood clay (21st Ann. Rept. Indiana Geol. and Nat. Resources, 1897, pp. 248, 252, 254, 257), demonstrating that this upper clay should be referred to the top of the Osgood and not to the base of the Laurel section. Fossils occur at this horizon at several localities between Madison and New Marion, Indiana.

North of Osgood, both the lower and the upper Osgood clays tend to become more indurated. This is true especially of the lower Osgood clay, which becomes a more or less impure limestone northward. The upper Osgood clay, on the contrary, although frequently reduced to a thickness of less than two feet, usually may be recognized as the very characteristic soapstone layer, immediately beneath the base of the Laurel limestone, in Decatur and Franklin Counties. It is this upper Osgood clay or soapstone horizon which is most readily identified, lithologically, in the Niagaran sections near Lewisburg, Ludlow Falls, and Covington, Ohio, as forming a part of the Osgood section in that area. Whatever rock occurs between this clay horizon and the Euphemia dolomite is referred to the Laurel limestone, and, in a similar manner, whatever rock occurs between this clay horizon and the top of the Brassfield limestone is included, along with the clay itself, in the Osgood formation. Since there is little change in the thickness of the Laurel limestone and of the Osgood clay in proceeding from Lewisburg eastward to Ludlow Falls and Covington, it is probable that these members of the Niagaran section extend farther eastward, but no equivalent to the Laurel limestone is present in the sections at Springfield, Yellow Springs, or Cedarville, and the clayey section at those localities evidently is the northward extension of the Crab Orchard clays of southern Ohio and eastern Kentucky, and may not be the exact equivalent of the Osgood clay of Indiana. Between Ludlow Falls and Covington, on the west, and Springfield and Yellow Springs, on the east, no clear exposures of the Niagaran strata immediately below the Euphemia horizon are known. This evidently was the reason why Prosser did not follow his Niagaran sections farther eastward (Journal of Geology, 1916, pp. 334–365).

In the more southern counties of Ohio, chiefly in Highland and Adams Counties, the Niagaran section, in descending order, is as follows:

Cedarville dolomite, with sandy layers near top.
West Union formation { Lilley member / Bisher member
Crab Orchard clay shale
Dayton limestone
Brassfield limestone.

At Hillsboro, Ohio, the West Union formation is separable into two members containing a very different fauna. The upper, or Lilley member, exposed at various localities on Lilley Hill, consists of about twenty feet of massive limestone usually overlaid by two or three feet of clay. It has been identified with certainty so far only in the vicinity of Hillsboro. The lower, or Bisher member, typically exposed northeast of the Bisher dam, contains a very characteristic fossil horizon about nine feet above its base, and several other layers, less abundantly fossiliferous occur between twelve and twenty feet farther up. This lower horizon appears to have a much wider horizontal extension. Along the creek, half a mile west of Port William, about seven miles north of Wilmington, the total thickness of West Union formation is less than five feet. It immediately underlies the Cedarville dolomite, and appears to represent the fossil horizon which at Hillsboro occurs nine feet above the base of the Bisher member. Farther northward, the West Union formation appears to be entirely absent.

In the vicinity of Hillsboro, Ohio, the Crab Orchard formation consists of 62 feet of clay underlaid by the Dayton limestone, 3.5 feet thick. The latter contains *Pentamerus oblongus* at several localities: Two miles west of Peebles, two miles south of Bellbrook, and near Dayton (Ohio Geol. Survey, 1870, p. 280). This Dayton limestone may correspond approximately to the Walcott limestone division of the Clinton formation in Niagaran section at Rochester, New York.

In the upper part of the Crab Orchard clay shale, in northern Kentucky and southern Ohio, thin layers of indurated shale occur which contain *Liocalymene clintoni*, *Beyrichia latatriplicata*, and other fossils. Fossils have been found at this horizon in the exposures a mile west of Peebles, Ohio, and the horizon probably may be traced as far northward as Hillsboro, Ohio. It evidently corresponds to the typical Clinton of New York, as exposed at Clinton, in that state.

North of Hillsboro, Ohio, the Crab Orchard clay shale section changes rapidly in character. No equivalent to the upper fossiliferous part of the Crab Orchard clay shale may be recognized at Leesburg, 11 miles northward. Here the clay is represented by a more or less indurated and imbedded rock which may soften up under the influences of weathering, but

which does not resemble the softer clay sections of more southern areas. The same lithological appearances are presented by the exposures on following the stream westward from the first exposures of the Crab Orchard formation, half a mile west of Port William, 18 miles northwest of Leesburg. They characterize the exposures also west of Cedarville, west of Clifton, and at Yellow Springs. At Centerville, the more or less indurated clayey strata, overlying the Dayton limestone, are interbedded with thin layers which are sufficiently calcareous to suggest impure limestones. Near the Soldiers' Home, west of Dayton, the limestone layers interbedded with the more shaly courses in the equivalent of the Crab Orchard section are more calcareous, and thicker, frequently attaining a thickness of three or four inches, or more, and resemble the underlying Dayton limestone, which is softer and less white here than southeast of Dayton, and at Centerville. At Lewisburg, Ludlow Falls, and Covington, the equivalent of the Crab Orchard section has become a continuous succession of limestones no longer to be readily differentiated from the typical Dayton limestone beneath.

In the present state of our knowledge it seems probable that the Osgood clay of the Lewisburg section belongs above the Crab Orchard clay section of Highland and Adams Counties, in Ohio, and is not merely an attenuated equivalent of the latter.

The Dayton limestone is regarded as forming merely the base of the Crab Orchard formation. The *Liocalymene clintoni* horizon, at the top of the Crab Orchard formation, may belong below the Rochester shale, rather than be equivalent to the latter.

The discrepancies between the Niagaran sections east and west of the present Cincinnati geanticline suggest an origin at least as early as the early Niagaran.

Holophragma calceoloides Lindstrom.

Plate VIII, Figs. 3A–K.

1865. Hallia calceoloides, Lindström. Ofvers. Vet. Akad. Förhandl., XXX, L. C., p. 289, pl. 31, figs. 9-11. Id. Nomina Foss. Sil. Gotl. p. 7.
1879. Cyathophyllum calceoloides, Quenstedt. Petrefactenkunde Deutschlands, Pt. I, vol. 6, p. 410, pl. 156, figs. 90-92.
1885. Cyathophyllum calceoloides, Lindström. List of Fossils of Gotland, p. 19.
1888. Cyathophyllum calceoloides, Lindström. List of Fossil Faunas of Sweden, Pt. II, p. 21.
1896. Holophragma calceoloides, Lindström. Bihang t. K. Sv. Vet. Akad. Handl. vol. 21, Afd. IV, No. 7, pl. VI, figs. 74-86.

Corallum simple, usually not exceeding 35 millimeters in length, but occasionally attaining a length of 40 millimeters. Cardinal side strongly flattened, giving the calice a subtriangular outline (Fig. 3D). Lateral margins of corallum more or less strongly angular. Viewed from the side, the transverse wrinkles are seen to incline from the cardinal side strongly forward and downward, and the cardinal side is straight or only moderately curved for the greater part of its length. Toward the calice, the corallum frequently curves more strongly forward, (Fig. 3B), and the outline of the calice becomes transversely oval or nearly circular (Fig. 3H). At the same time, the lateral diameter of the corallum frequently becomes shorter, and sometimes the antero-posterior diameter also becomes less, suggesting gerontic conditions. The two narrow longitudinal ridges locating the cardinal septum usually are distinctly defined along the lower half of the cardinal side of the corallum, but become less conspicuous along the upper half. The alar septa are located along the lateral angles of the corallum.

From 25 to 30 larger septa line the interior of the calice, alternating with which are an equal number of short septa confined to the upper part of the calice. The cardinal septum is only slightly more conspicuous than the remainder. Those septa which are intermediate between the cardinal and alar septa tend to meet at the bottom of the calice, in the more triangular forms, so as to present the appearance of two groups, one on each side of the cardinal septum (Fig. 3K). In the calices with more circular outlines, this tendency toward grouping is not conspicuous, and it varies greatly in different individuals. Occasionally the second or third one of the larger septa on the right and left of the cardinal septum becomes more conspicuous than the rest. (x in Fig. 3K). Together with the cardinal septum, they form a group of three somewhat more prominent septa, chiefly in specimens retaining their triangular outline even at the aperture of the calice. In most specimens, especially those with a circular outline at the aperture, these septa are not more conspicuous than the rest.

In *Anisophyllum trifurcatum*, Hall, it is the two alar septa which in conjunction with the cardinal septum, form a group of three somewhat more conspicuous septa.

In *Holophragma calceoloides*, the septa are not twisted together at the center, as in *Streptelasma*, and the cardinal septum is not located in a fossula, as in *Zaphrentis*.

Typical *Holophragma calceoloides* occurs in layers *c* and *d* of the Silurian of Gotland. It is recorded from the coast at Wisby, Guisvard, Staf, Nyrefsudd in Tofta, Likkershamm, Kristklint, Hallshuk, on west shore of Kapellshamn.

The specimens here figured and described were obtained in the upper part of the West Union formation, in the Silurian at Hillsboro, Ohio. Here they are most abundant at the Zink or

Corporation quarry, immediately south of the Marshall pike, in the eastern part of the town. At this quarry, the *Pentamerus* bearing dolomite, correlated with the Cedarville dolomite of the more northern sections in southwestern Ohio, is underlaid by two feet of clay shale, and next by fourteen feet of a bluish, apparently argillaceous limestone, rather massively bedded. Fossils are abundant in the clay shale, much less abundant in the upper part of the massive limestone, and comparatively scarce in the middle and lower parts of this limestone. *Holophragma calceoloides* also is common in the two-foot clay shale, and occurs in moderate numbers in the upper half of the underlying massive limestone.

At the Trimble, Beech, or Railroad quarry, a third of a mile north of the Zink quarry, the *Pentamerus* bearing dolomite, correlated with the Cedarville dolomite, is underlaid by clay shale, three feet three inches thick. Below this occurs the full section of the blue massive-bedded limestone seen in the lower part of the Zink quarry. Here its total thickness is 21 feet, and it is underlaid by well-bedded, laminated, cherty limestone in which fossils are few. *Holophragma calceoloides* occurs here both in the clay shale and in the upper half of the underlying massive limestone, but in much smaller numbers than at the Zink quarry.

Holophragma calceoloides occurs also at two localities along the Danville pike, west of Hillsboro. The first locality is a quarry south of the pike, about a quarter of a mile west of the town. Here it occurs in the upper part of the massive blue limestone. The clay shale is absent, and the overlying dolomite does not contain *Pentamerus*. The second locality is a quarry north of the pike, and about an eighth of a mile farther west than the first quarry. Here *Pentamerus* is common at the top of the quarry. Below the *Pentamerus* bearing horizon is a section ten feet thick in which the dolomite contains no *Pentamerus*. Below this ten-foot section occurs the massive blue limestone, containing *Holophragma calceoloides* in its upper half. At neither of these two localities is the *Holophragma* common. At the first locality, south of the Danville pike, the shaly, thin-bedded, cherty rock, seen at the base of the Trimble quarry, is exposed.

The two-foot clay shale layer, and the 21-foot massive blue limestone section at the Trimble, Beech or Railroad quarry,

east of Hillsboro, Ohio, contain a fauna quite distinct from that found in the lower third of the West Union formation, northeast of the Bisher dam, a mile southeast of Hillsboro, on Rocky Fork. It is sufficiently distinct to merit a separate designation locally, and hence the name *Lilley* bed or member is here proposed, to include both the clay shale and the underlying limestone, since they contain the same fauna. Both the Zink and the Trimble quarries are located on the western side of Lilley hill, along the eastern edge of Hillsboro. For the underlying part of the West Union formation the term *Bisher* member is proposed, the typical fauna occurring northeast of Bisher dam, a mile southeast of Hillsboro, and outcropping along the hillside northward as far as the lower part of the valley immediately southeast of the town. The most abundant fossil horizon is about nine feet above the base of the formation, another fossiliferous layer occurs from 12 to 20 feet farther up.

Zaphrentis digoniata, sp. nov. Plate VIII, Fig. 1 A, B, C, D, E, F, G.

Corallum strongly compressed laterally, the antero-posterior angle varying from 40 to 45 degrees, and the lateral diameter equalling from 45 to 55 hundredths of the antero-posterior diameter. The two narrow longitudinal ridges locating the position of the cardinal septum are somewhat more conspicuous than the other longitudinal ridges marking the exterior of the corallum, at least along the lower half of the corallum, and are located along the posterior angle. The anterior and posterior angles are equally well defined, and vary from almost acute, in some specimens, to more or less strongly rounded. Frequently the specimens are more acutely angled at the base and more strongly rounded toward the top. The specimens usually do not exceed 35 millimeters in length. The tip of the base of the corallum frequently curves slightly forward, and the transverse striae also slope slightly downward from the rear toward the front, on lateral view.

The calice varies from 10 to 15 millimeters in depth. A deep but narrow fossula is located on the cardinal side of the corallum and extends as far as the center of the calice. The cardinal septum appears to have varied greatly in the extent to which it extended inward from the wall of the corallum toward the center of the calice. If alar fossulae existed, these must have been shallow and inconspicuous. The number of septa apparently varies in different specimens from 30 to 40, alternating with an equal number of much smaller size, which could be described as acute septal ridges.

Zaphrentis digoniata is not rare in the two-foot clay shale and in the upper part of the massive blue limestone, forming the Lilley member of the West Union formation, at the Zink or

Corporation quarry, in the eastern part of Hillsboro, Ohio. It occurs at the same horizon, but in smaller numbers, at the Trimble or Railroad quarry, a third of a mile north of the Zink quarry. Specimens occur also in the upper part of the massive blue limestone exposed in the quarry a quarter of a mile west of Hillsboro, on the Danville pike.

Specimens not to be distinguished from typical *Zaphrentis digoniata*, from the Lilley member of the West Union formation, at Hillsboro, occur in the upper third of the quarry at Cedarville, Ohio, where only the Cedarville dolomite is exposed. Since the upper limits of the Cedarville dolomite can not be determined in the area surrounding Cedarville, nothing more definite regarding the stratigraphic position of these Cedarville specimens can be stated at present. The specimens occur chiefly as casts of the calices, but impressions of the exterior of the entire corallum also occur.

In *Streptelasma angulatum*, Billings, from the English Head and Charleton formations, in the Richmond of Anticosti, and in some of the younger specimens of *Streptelasma robustum*, Whiteaves, from the Richmond of the Red River Valley, in Manitoba, the corallum is more or less strongly angulate along the convex curvature of the corallum. In both species, the anterior outline is distinctly concave, and the posterior or cardinal outline is strongly convex, when the corallum is viewed from the side.

Since no attempt ever has been made to locate the exact horizon of the rich fauna in the quarry at Cedarville, Ohio, in that part of the Silurian section usually referred to the Cedarville dolomite, the following notes may be of service. At the quarry immediately north of the railroad and about a third of a mile west of the railroad depot, the top of the exposed rock is about two feet above the level of the railroad track. The section here is as follows, given in descending order:

Cedarville dolomite, richly fossiliferous ..... 12 ft.
Amphicoelia costata horizon
Cedarville dolomite, fossils common ..... 7 ft.
Horizon 1063 feet above sea level.
Cedarville dolomite, massive, breaking up into irregular layers; fossils few ..... 3 ft.
Cedarville dolomite, massive, crinoidal, fossils few ..... 7 ft., 6 in.
Cedarville rock, not exposed, covered by water collecting at bottom of quarry; fossils few ..... 11 ft.

Half a mile west of the quarry, but on the northern side of the Columbus pike, is a house below the level of the pike. A lane leads past the eastern side of the house downward into the ravine formed by Massie Creek. The house if about 1005 feet above sea level, and rock occurs at about the same level along the lane leading toward the creek. Here the following section is shown, in descending order:

Cedarville dolomite, massive.....38 ft.
Horizon about 967 feet above sea level.
Dolomitic limestone, breaking up into thin layers, and regarded as equivalent to the Springfield dolomite.....13 ft.
Dolomite, massive, showing bedding toward the top, regarded as equivalent to the Euphemia dolomite.....7 ft., 6 in.

The dip of the rock within this half mile, from the exposure on Massie Creek to the quarry north of the railroad in Cedarville, is not known, but is regarded as low. If this be true, the level at which fossils become common in the quarry is about 36 to 40 feet above the *base* of the Cedarville dolomite, as identified along Massie Creek. Since the total thickness of Cedarville dolomite exposed at the eastern Mills quarry, at Limestone City, southwest of Springfield, is only 19 feet, the level at which fossils become common in the Cedarville quarry apparently is about 17 to 20 feet above the top of the highest part of the Cedarville dolomite exposed at the eastern Mills quarry. Since most of the fossils collected in the quarries southeast of Springfield come from the lower, more massive and porous part of the Cedarville dolomite, the level at which fossils become more common in the Cedarville quarry may be estimated at from 25 to 30 feet above the level of the top of the zone from which most of the fossils collected southwest of Springfield have been obtained. This difference in level between the richly fossiliferous zone in the Cedarville quarry and that in the quarries southeast of Springfield accounts readily for the differences in faunal content noted.

At the Mills Quarries, southwest of Springfield, the following order of succession, in descending order, is noted:

Cedarville dolomite:
Porous rock.....3 ft.
Less porous rock.....1 ft., 6 in.
Thin bedded, fine grained rock.....3 ft., 3 in.
Massive, porous, richly fossiliferous rock.....11 ft.
Springfield dolomite, fine-grained, well bedded.....10 ft.
Transition rock, dense, but somewhat mottled.....4 ft.
Euphemia dolomite, porous.....8 ft.

Cyathophyllum roadsi, sp. nov. Plate IX, Figs. 1 A–J.

Corallum elongate turbinate in its younger stages, with a tendency toward cylindrical form in its later stages. Basal angle usually varying between 20 and 30 degrees, but sometimes the corallum begins as a narrow, sub-cylindrical growth, enlarging more rapidly later, and then becoming subcylindrical again. Corallum sometimes changing its direction of growth in a more or less abrupt or geniculate manner. Epitheca with distinct longitudinal septal furrows, numbering 40, 41, 43, 44, 46, 46, 46, and 51 in the specimens here illustrated. Along the interior of the wall of the corallum there is a corresponding number of septa. These are alternately short and long, the shorter ones usually extending scarcely a millimeter from the wall. In the spaces between the shorter septa and the longer septa on each side dissepiments occur in greater or smaller numbers, dividing the spaces into more or less irregular vesicular compartments. This vesicular tissue usually does not extend more than a millimeter from the wall of the corallum. Even the longer septa usually do not reach the center of the corallum, but terminate as ridges on the upper surfaces of the tabulae, leaving the central parts of the latter more or less free. In some of the specimens the vesicular tissue unites the proximal free margin of the shorter septa to one of the adjacent longer septa in such a manner as to produce the appearance of the bifurcation of the longer septa in a distal direction.

Tabulae distinctly developed and complete, at least as far as the narrow vesicular zone, forming a conspicuous part of vertical sections of the corallum. Tabulae usually irregularly concave. When the calice is deep and funnel-like, the depth equalling or exceeding the width, the tabulae are correspondingly more concave and the vesicular spaces are elongated in a direction more or less parallel to the lateral walls of the calice. When the calice is more shallow, the tabulae are less strongly concave. No fossula has been detected.

Along the basal half of the exterior of the corallum the location of the cardinal and alar septa may be recognized distinctly by means of the septal furrows, as in typical *Zaphrentidæ*. The cardinal septum almost invariably lies along the convexly curved side of the basal part of the corallum. In that part of the corallum where the dissepiments are most abundant, usually within one millimeter of the wall, there appears to be a tendency toward the deposition of steroplasm.

From the Lilley member, forming the upper part of the West Union formation, in the Zink or Corporation quarry, in the eastern part of Hillsboro, Ohio. Named in honor of Miss Katie M. Roads, who for several years has been giving special attention to the fauna of the West Union formation in the vicinity of Hillsboro, Ohio.

Among Silurian forms, this species is sufficiently characterized by the narrow vesicular zone, the broad area occupied by

the tabulæ, and the tendency of even the longer septa to terminate before reaching the center of the corallum. The frequency with which the proximal free margins of the longer septa show evidence of twisting or contortion, even when not reaching the center of the corallum, is another characteristic feature.

Acervularia (?) **paveyi,** sp. nov. Plate X, Fig. 10.

Corallites forming astraeiform colonies 12 centimeters or more in diameter. Corallites polygonal, usually more or less six-sided, the transverse diameters varying from 13 to 20 millimeters, with 15 millimeters as a fair average. The walls are thin and distinctly defined. The central part of the calice appears to be surrounded by a cylindrical wall varying from 6 to 10 millimeters in diameter, with 7 or 8 millimeters as a fair average. In general, the cylindrical walls are situated about half way between the center of the calice and the middle part of the surrounding polygonal walls. Between 45 and 50 septa extend from the polygonal walls toward the central part of the calice; of these practically all appear to pass into the space within the cylindrical wall although only a part reach the center of the calice. The septa are connected by dissepiments in the spaces both within and without the cylindrical wall. In the specimen here figured, dissepiments are clearly preserved within several of the circular spaces included by the cylindrical walls, but are much less satisfactorily indicated in the exterior part of the corallites, between the central cylindrical wall and the outer polygonal wall. In none of the corallites is there any evidence of horizontal tabulae within the central space enclosed within the cylindrical wall. In one of the corallites there apparently is evidence of horizontal tabulae resting on vesicular tissue, but in all of the other corallites there is no clear evidence of the presence of tabulae.

From *Strombodes*, the species here described is readily distinguished by the conspicuous development of septa extending vertically throughout the corallites and the absence of numerous infundibuliform tabulæ, resting on a conspicuous vesicular tissue. From true *Acervularia*, it differs in the absence of numerous tabulæ within the central area, enclosed by the cylindrical wall. The continuation of the septa from the exterior prismatic walls of the corallites to within the space enclosed by the central, cylindrical wall, indicates that the structure of the latter needs further elucidation, but this apparently can not be furnished by the silicified specimen at hand. From *Prismatophyllum*, it differs in the presence of the central cylindrical wall, and in the absence of numerous tabulæ within the central cylindrical part of the corallites.

From the Lilley member, forming the upper part of the West Union bed, in the Zink or Corporation quarry, in the eastern part of Hillsboro, Ohio. Named in honor of Henry Pavey, an eminent member of the bar of southwestern Ohio, who has also given considerable attention to the geology of the area surrounding Hillsboro.

Grabauphyllum johnstoni, gen. et sp. nov. Plate XI; Fig. 9.

Corallum composite, composed of large polygonal corallites from 20 to 30 millimeters in diameter. Calices comparatively shallow, varying from 10 to 12, occasionally 15 millimeters in depth. Walls separating the corallites with vertical ribs, evidently corresponding to the septal ridges of other corals. Outer part of the corallites coarsely vesiculate. Near the lower part of the calices this vesiculate tissue extends to a distance of 3 to 6 millimeters from the walls between the corallites toward the center of the calices, leaving a circular or elliptical space, in the center, having diameters varying from 15 to 20 millimeters, in which this coarsely vesicular tissue is absent. On their lower surfaces, the plates forming this vesicular tissue are smooth; on their upper surfaces they frequently show septal lines, more or less denticulate as in some species of *Cystiphyllum*. In the outer zone of the central circular area, for a distance of 3 to 4, sometimes 5 millimeters, radiating septa are numerous and well defined. The number of these septa varies from 45 to 55 in the different corallites. They are connected laterally by numerous short dissepiments. Tabulae are abundant in the central parts of the corallites. These are chiefly elliptical in outline in the specimen at hand, and vary from 6 to 10 millimeters in width, and from 10 to 15 millimeters in length. Viewed from the lower side they appear smooth, but it is probable that septal ridges extended over their upper surfaces for some distances toward the center; how far, can not be determined from the specimen at hand.

Found in the Niagaran dolomite near McCook, 5 miles west of Chicago, Illinois, by William Johnston. Genus named in honor of Prof. Amadeus Grabau, of Columbia University in recognition of his valuable contributions to our knowledge of corals.

The distinguishing features of *Graubauphyllum* are the composite corallum, the outer coarsely vesicular zone, the intermediate septate zone, and the central tabulate area.

It is not unlikely that *Acervularia clintonensis*, Nicholson, may prove to be congeneric. This species was described (Ohio Pal. II, 1875, p. 227, Pl. 23, Figs. 2, 2a) as coming from the Clinton group at Yellow Springs, Ohio. Fortunately, it is known that specimens of fossils from the Cedarville dolomite in

early days occasionally were labelled erroneously as coming from the Clinton. For instance, the specimen of *Atrypa nodostriata*, Hall, from the Cedarville dolomite at Yellow Springs, Ohio, which is numbered 12103 in the collections at Columbia University, is there labelled as coming from the Clinton, and in former days I have seen similar erroneous labelling elsewhere. Under these circumstances it is not unlikely that *Acervularia clintonensis* may prove to be a Cedarville dolomite species. It is a much smaller species than *Grabauphyllum johnstoni*. The corallites average about 8 mm. in diameter. The outer zone is described as consisting of loose vesicular tissue in which the septa often are imperfectly developed. The intermediate zone consists of 40 to 46 slender septa, alternately large and small, united laterally by transverse dissepiments. Since no dissepiments are indicated in the central parts of the corallum, this part may correspond to the abundantly tabulate part of *Grabauphyllum*. The present location of the type of *Acervularia clintonensis* is unknown. It is assumed to have been destroyed in the fire which consumed the collections of Toronto University, years ago.

Calostylis parvula sp. nov. Plate VIII, Figs. 2A, B, C, D, E, F; Plate IX, Fig. 5.

Coralla simple, usually not exceeding 25 millimeters in length, but sometimes equalling 35 millimeters. Most of the specimens are curved strongly toward the base, producing a concave outline anteriorly, and convex outline posteriorly, when the corallum is viewed from the side. The wall of the corallum is thin, and is marked by distinct transverse striae and by more or less indistinct longitudinal lines, intermediate in position to the septa on the interior. Frequently the wall has weathered away, especially along the upper part of the corallum, exposing the septa.

Larger septa, about 30 to 35, extend toward the center, and there form a central mass (Fig. 2F), occupying about one-third of the width of the corallum. This central mass probably rises only a very short distance above the bottom of the calice. Within this central mass the proximal parts of the septa can be followed only a short distance since they form an irregularly vesicular growth, transversed by irregularly communicating pores. If any part of this central structure is to be interpreted as equivalent to tabulae, then these tabulae also are penetrated by pores.

Pores also traverse the septa, but vary greatly in number. Between the larger septa, which extend from the wall of the corallum as far as the central vesicular mass, there is an equal number of shorter septa, alternating with the larger ones. In some specimens, the shorter

septa extend about half way from the wall of the corallum toward the central vesicular mass (Figs. 2 E, F); in others, they are shorter (Fig. 2 D). The larger and shorter septa are connected laterally by lamellose structures traversed by pores similar to those traversing the septa. These lamellose structures evidently correspond to the dissepiments of other corals.

In some specimens, the proximal edges of the shorter septa appear united to one side of one of the adjacent longer septa, usually the one nearer the cardinal side (Fig. 2F). Between the proximal edges of the shorter lamellae and the central vesicular mass, the number of dissepiments connecting the sides of the longer septa usually is comparatively small.

The pores traversing the central vesicular mass frequently equal a quarter of a millimeter in diameter. Pores of equally large dimensions have been noticed also traversing some of the septa, but the pores vary greatly in size, and some of them scarcely equal a twelfth of a millimeter in diameter.

Calostylis parvula has been found so far only in the upper part of the Laurel limestone in the Reinheimer quarry, at New Paris, Ohio. Here it is associated with *Pisocrinus gemmiformis*, *Stephanocrinus osgoodensis*, *Heliolites subtubulatus*, and *Atrypa reticularis*.

Since the Reinheimer quarry section is the most western one at which all of the Silurian strata occurring north of the Ordovician area in southwestern Ohio have been identified, and since this identification presents some difficulties, the following data may prove of some interest. The section is given in descending order:

Cedarville dolomite.
- Porous dolomite, massive ..... 6 ft.
- Thinner bedded dolomite ..... 1 ft. 3 in.
- More massive dolomite ..... 2 ft.
- Porous massive dolomite, containing *Pentamerus oblongus* and *Phanerotrema occidens* ..... 17 ft. 6 in.

Springfield dolomite.
- Rock resembling Dayton limestone, with *Pentamerus oblongus* common within 6 inches of the top ..... 5 ft. 6 in.
- Rock resembling overlying layers, but very cherty ..... 7 in.

Euphemia dolomite.
- Rock blotchy and porous, weathering darker. The blotches are 2 to 3 inches wide ..... 2 ft.
- Transition rock, with white blotches, but not porous ..... 8 in.

Laurel limestone.
- Rock resembling Dayton limestone, free of chert ..... 8 ft. 4 in.
- Very cherty white limestone, with *Pisocrinus gemmiformis*, *Stephanocrinus osgoodensis*, and *Calostylis parvula* near top ..... 16 ft. 9 in.
- Base of Reinheimer quarry. Underlying strata are exposed along ditch leading west from quarry.

Osgood formation.
Represented here by soft limestones, partly thinbedded and interbedded with thin clayey layers.....4 ft.

Dayton limestone.
Whitish limestone, poorly exposed.....7 ft. 6 in.

Brassfield limestone.
Only the top of this limestone is exposed, near the western end of the ditch.

The name Euphemia dolomite is proposed here for that horizon which Prosser, in his paper on The Classification of the Niagaran Formations of Western Ohio (Journal of Geology, 1916, pp. 334–365) called the Mottled Zone. The type locality for the Euphemia dolomite is located at the quarry described by Prosser as the Lewisburg Stone quarry. This quarry lies a mile northwest of Lewisburg. Euphemia is located a half mile north of Lewisburg and is a little nearer to the quarry, so that this name is available for the Mottled zone.

Calostylis has been identified hitherto only from one horizon and area in American strata, namely, in the Waco limestone member, in the lower third of the Alger formation of eastern Kentucky, where *Calostylis spongiosa*, Foerste, is found. This Alger formation corresponds stratigraphically with the so-called Niagara shales of the various reports written by Prof. Edward Orton for the former Ohio Geological Survey. There is no evidence, however, that any equivalent of the Waco member is to be found within 40 miles of the Ohio River, even in eastern Kentucky. Apparently it is only the overlying part of the Alger formation, consisting of the Estill clay, which extends into southern Ohio. It has been assumed at times that the Alger formation of eastern Kentucky and the adjacent parts of Ohio correspond stratigraphically with the Osgood formation of Indiana and the adjacent parts of Ohio, but this assumption never has been verified.

Calostylis denticulata, Kjerulf, the type of the genus, was described from Wisby, on the island of Gotland, Sweden, where it ranges for 18 miles along the shores of the Baltic. It occurs also at Malmo, an island near Christiania, Norway. Judging from the figures of this species presented by Lindstrom, the central vesicular mass is not well developed in young specimens, the septa apparently reaching the center. The tendency of the proximal edges of the shorter septa to unite with the lateral edge of one of the adjacent longer septa also is shown. Two

species of *Calostylis* have been described also from the Silurian of Great Britain. Of these, *Calostylis lindströmi*, Nicholson and Etheridge, occurs near Girvan, in Scotland, and *Calostylis* (?) *andersoni*, Nicholson and Lydekker, in Shropshire, England.

Calostylis belongs to an increasing number of peculiar genera whose distribution suggests a former connection of American epicontinental seas during Silurian times with those of the Baltic area, and with Great Britain.

Calostylis belongs to the *Tetracoralla*. This relationship is more apparent in *Calostylis parvula*, here described, than in the type species, owing to the simpler construction of the septa. In *Calostylis denticulata* the septa of the older specimens tend to have a spongy structure. In *Calostylis parvula* the pinnate arrangement of the septa, diagnostic of the *Tetracoralla*, frequently is distinct. (The Relation of the Tetracoralla to the Hexacoralla, W. I. Robinson, 1917. Trans. Connecticut Acad., p. 173.)

Holocystites greenvillensis, sp. nov. Plate IX, Figs. 3A, B, C; Plate X, Fig. 8.

Three specimens, none of which preserves either the base or the summit; each retaining five horizontal rows of plates, each row consisting of eight plates. In each specimen the third horizontal row is located at mid-length, and forms the widest part of the theca. All of the plates, as far as retained, are hexagonal in outline, excepting possibly the uppermost series, which may have been pentagonal. At one side of the upper end of each of these specimens there is evidence of a protuberance which is regarded as locating the anal opening. Orienting the specimens in such a manner as to place this protuberance at the rear, it is noticed that the plates along the middle part of the right side of the theca (Figs. 3 A, B) are narrower, while those on the left side (Fig. 3 C) are wider than the remainder. The thickness of the plates is about half a millimeter. The surface of the plates is distinctly and irregularly granulose, the larger granules equalling about three-eights of a millimeter in width.

Among described species, *Holocystites greenvillensis* resembles most closely the type of *Holocystites abnormis*, Hall (Twentieth Annual Report, State Cabinet of Natural History, New York, 1868, Pl. 12, Fig. 7), however, the plates of the upper two rows are very much narrower, especially on the right side of the theca. Moreover, the general outline is more fusiform, and the outline near the anal protuberance tends to be more or less distinctly concave. In addition, the size is much smaller.

Compartively little is known regarding the genus *Holocystites* at present. If *Holocystites cylindricus*, Hall (Loc. cit. Pl. 12, Fig. 4) be regarded as the type of the genus, then only the six specimens figured by Hall under the terms *Holocystites cylindricus*, *H. abnormis*, and *H. alternatus* are congeneric among described forms referred to this genus. The material at hand is not sufficient to determine whether these six specimens are to be referred to only three species, as done by Hall, or whether they represent six distinct species.

The type of *Holocystites cylindricus* (Loc. cit., Pl. 12, Fig. 4) is labelled as obtained by Dr. Daniel, near Grafton, Wisconsin. It retains seven horizontal rows of plates, with eight plates in each row. At the base, there is a trace of an eighth row, and there may have been more. The oral and anal apertures are not preserved. The surface of the plates probably was ornamented by low, broad pustules. The more or less radiating, short, linear markings figured by Hall probably represent short horizontal pores immediately beneath the epithecal layer of the plates. The interior of the plates may have been traversed by numerous, coarse, vertical pores.

In the second specimen figured by Hall under the term *Holocystites cylindricus* (Fig. 5) the number of plates in the horizontal rows is uncertain. The oral aperture is six millimeters in diameter and was either circular or subpentagonal in form. At a distance of two millimeters from this aperture, on the side opposite to that figured by Hall, is the anal aperture, circular in form, and almost five millimeters in diameter. This anal aperture is located in the lower part of the uppermost row of those plates which are distinctly outlined, but the possibility of a row of very short plates immediately surrounding the oral aperture can not be disproved. This, and the following specimens, are from Racine, Wisconsin.

In the third specimen figured by Hall under *Holocystites cylindricus* (Loc. cit. Pl. 12, Fig. 6; Pl. 12a, Fig. 8) there are eight horizontal rows of distinct plates, with a possibility of a ninth, circum-oral row, consisting of very short plates. Neither the oral nor anal aperture is distinctly indicated. The surface of the plates is covered by low, broad pustules. The segments of the column are only indistinctly indicated.

(*To be continued.*)